all observations are to be reduced and published without delay."

The fundamental instrument, the transit circle, has been kept well at work on the regular observations of the sun, the moon, the planets and fundamental stars, together with other stars, which, in the annual catalogue for 1883, number 1,550. The total number of transits observed was 5,213, and of circle-observations, 5,049, — a larger number of meridian observations than usual. But what is of more interest, the reductions of these observations are maintained in a state of forwardness unknown in national observatories generally. The computations on certain stages of the reductions of the meridian-work were reported to be well advanced on all observations up to the middle of May, 1884. It is worthy of note here, that the mean correction of the 'Nautical almanac' positions of the moon in right ascension turns out to be no larger than $-0^s.03$ for the year 1883. This interesting concordance of theory and observation is due to the adoption in the 'Nautical almanac' of Professor Newcomb's corrections to the 'Tables de la lune' of Hansen, which are the same as those employed in the construction of the 'American ephemeris.'

The observations with the altazimuth have been restricted to the period from the last quarter of the moon to the first quarter in each lunation; it being considered, that, from the first quarter to the last, the observations of the moon on the meridian will be obtained in sufficient abundance. The astronomer royal regards it as evidence of the great value of the altazimuth, that, during the former period, nineteen observations of the moon were secured with it at times when the moon's meridian-passage took place within three hours of the sun, and when observation with the transit circle was thus impracticable.

With the equatorially mounted refracting telescopes, only the usual observations were conducted; but, with the spectroscope, results of much importance and interest were reached. "For the determination of motions of stars in the line of sight, four hundred and twelve measures have been made of the displacement of the *F* line in the spectra of forty-eight stars, ninety-one measures of the *b* lines in nineteen stars, and two measures of the *D* lines in one star, besides measures of the displacements of the *b* and *F* lines in the spectra of the east and west limbs of Jupiter, and in the spectra of Venus and Mars. . . . Some preliminary measures have also been made of the *F* line in the spectrum of the Orion nebula. The progressive change in the motion of Sirius from recession to approach, alluded to in the last two reports, is fully confirmed by numerous observations since last autumn, and a change of the same character is indicated in the case of Procyon."

With regard to solar photography, undertaken with the view to determine the amount of spotted area, it is interesting to note that the heliograph, which up to the present time has given pictures of four inches diameter only, has been modified so as to take eight-inch pictures, as was suggested two years ago by the solar-physics committee. The photographs taken in India under the auspices of the same committee are now sent to Greenwich for reduction, thus resulting in a considerable increase in the number of days for which photographs are available. In 1883, for example, photographs on 215 days at Greenwich are supplemented by those on 125 days of India, giving a total of 340. In 1882, to 201 days at Greenwich were added 142 India, thus leaving only 22 days without photographs in the entire year. In the photographic branch of the observatory-work there has been much pressure "during the long-continued maximum of sun-spots, the work of measuring the photographs having been somewhat further increased by the adoption of large-scale photographs of the sun."

The acquisition of the Lassell equatorial, and the uses to which the astronomer royal proposed putting it, were mentioned in the report of the previous year. A new dome for this telescope, thirty feet in diameter, and covered with *papier-maché* on a framework of iron, was completed by the Messrs. T. Cooke & Sons of York in March last; and the building is now about complete in all its details. The instrument itself has been generally cleaned and repaired. The mirror is in very good condition as regards polish, and the definition on stars is satisfactory.

The magnetic and meteorological observations have been continued with the same regularity as in previous years. The mean temperature of 1883 was 49°.3, being 0°.4 lower than the average. The highest air-temperature was 85°.1, on Aug. 21; and the lowest, 20°.6, on March 24. The mean daily motion of the air during the year was 291 miles, which is 12 miles more than the average. The number of hours of bright sunshine during 1883 was 1,241, being about 30 hours above the average of the six preceding years. Mr. Christie informs us that no definite connection was noticed between magnetic or electric disturbances and the phenomena of the remarkable sunsets of the past winter.

THE UNITED-STATES GEOLOGICAL SURVEY.

Annual reports of the United-States geological survey to the secretary of the interior, ii., iii. J. W. POWELL, director. Washington, *Government*, 1882–83. 55+588 p., 32 fig., 62 pl.; 18+564 p., 56 fig., 35+32 pl. 8°.

IT has often been remarked that the problems of geology are expressed in far simpler terms in America than in Europe, the birthplace of the science. It is hard to say whether it would have been better for geology if it had been born in a less adverse environment. Perhaps it might have developed more rapidly, but probably not so healthily. Perhaps the very difficulties of the problems of geology in Europe — the conflicts of the schools through which the young science passed — have tended to invig-

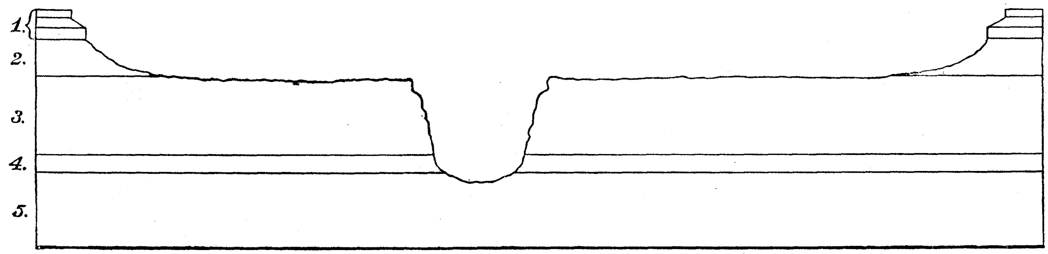
orate its life. However this may be, there can be no doubt, that, this stage of pupilage passed, it was well that a new and larger field was opened here on this continent, where its activity might be more productive, and its growth more steady. On the North-American continent, and especially in the United States, it would seem that each separate geological problem is stated in the clearest way. In stratigraphy, where shall we find a series so continuous and complete as in the region of the Wahsatch Mountains? In mountain structure, where are the extreme types so perfectly expressed as in the Appalachian on the one hand, and the basin ranges on the other? In land-sculpture, where are there examples so simple and grand as in the plateau region? Of the obscure phenomena of the glacial epoch, where may we hope to find an explanation, if not in eastern United States? In the still more obscure problems of chemical geology, such as the geneses of ore-deposits, — problems which have hitherto baffled the utmost efforts of science, — what field so promising as the American Cordilleras, where the process is still going on under our eyes? Finally, in paleontology, where are there fields richer than the paleozoic basin of the east, and the wonderful cretaceous and tertiary deposits of the west?

These reflections have been suggested by reading the two bulky volumes before us. There can be no doubt that the establishment of the U. S. geological survey is an epoch not only in the geology of this country, but in the science of geology itself. Excellent work has been done before by individual effort, by state surveys, and by surveys undertaken by the war and interior departments; but never before has the work been organized in a manner befitting so noble a field. The volumes before us are a proof of the excellence of the work being done: they consist of full abstracts of a series of monographs, most of which are yet unpublished. A simple enumeration of these is sufficient to show their great importance. They are Dutton's 'Physical history of the Grand Cañon district,' Gilbert's 'History of Lake Bonneville,' Russell's 'History of Lake Lahontan,' Hague's 'Geology of Eureka district,' Emmons's 'Geology of Leadville district,' Becker's 'Geology of Comstock lode,' Irving's 'Copper-bearing rocks of Lake Superior,' and Chamberlin's 'Terminal moraine of the second glacial epoch.' It is evident that only the most rapid review of these memoirs is possible here.

The geology of the plateau region, through the labors of Powell and Dutton, is so well known that only a brief recapitulation of its wonderful history is necessary. This region, now the highest in general elevation of the continent, was a sea-bottom, continuously or nearly so, from early carboniferous to the end of the cretaceous, and received, during this time, conformable sediments twelve thousand to fifteen thousand feet thick: this indicates, of course, a subsidence to the same extent. At the end of the cretaceous it began to rise, passing successively through brackish-water, fresh-water, land, and high-plateau conditions to the present time, the extreme elevation being not less than eighteen thousand to twenty thousand feet. Accompanying this elevation, and as its effect, there has been a general erosion by which from six thousand to eleven thousand feet thickness of strata have been removed over the whole area, leaving the plateau still from seven thousand to eight thousand feet high; and lastly, into this plateau, a cañon-cutting from three thousand to six thousand feet deep. The general erosion has given rise to a series of cliffs from a thousand to two thousand feet high, and extending for hundreds of miles; while the elevation, especially in its later stages, has broken the earth-crust into parallel oblong blocks from twenty to thirty miles wide and a hundred or more miles long, which, by settling unequally, have produced vertical displacements of a thousand to six thousand feet. These displacements, having occurred in comparatively recent times, have not yet been obliterated by erosion, and therefore still exist as cliffs. Thus, besides the east and west erosion-cliffs, there are also north and south displacement-cliffs: these latter pass by insensible gradations into monoclinal bends of the strata. As soon as the region became land, of course a river-system was established. As the region rose, the rivers cut down *pari passu*, and thus maintained their positions. The Grand Cañon itself, into which the tributaries drain, is in the axis of the elevation. Thus it has come to pass that the rivers run against the inclination of the strata, cutting deeper as the strata rise, southward. This remarkable persistence of river-beds, in spite of great orographic changes, was first pointed out by Powell.

The time when these different events occurred has been accurately determined by Dutton. In eocene times, nearly the whole plateau region was covered by the waters of a vast lake, in which many thousand feet of strata were deposited, — the same which yielded such treasures of mammalian remains to Marsh and

Cope. At the end of the eocene, this lake was drained by elevation, the present river-system was established, and the general erosion commenced. It is probable, that, during the miocene, the climate was moist, the rain excessive, and the general erosion very great. Most of the general erosion was done during this time. During the pliocene the elevation was greatly increased, the climate became dry, and, while a moderate general erosion continued, the stream-cutting became excessive. The upper, outer, and greater part of the Grand Cañon was made at this time (see the accompanying figure). Toward the end of the pliocene, things settled for a while: the streams reached a base-level, and cut no deeper for a long time. At the beginning of the quaternary, a somewhat rapid rising again began, and has continued to the present time. This last rising inaugurated the cutting of the inner cañon. The comparatively rapid rising of the pliocene and quaternary times produced the north and south faults, and, in connection with these, igneous outbursts on a grand scale.



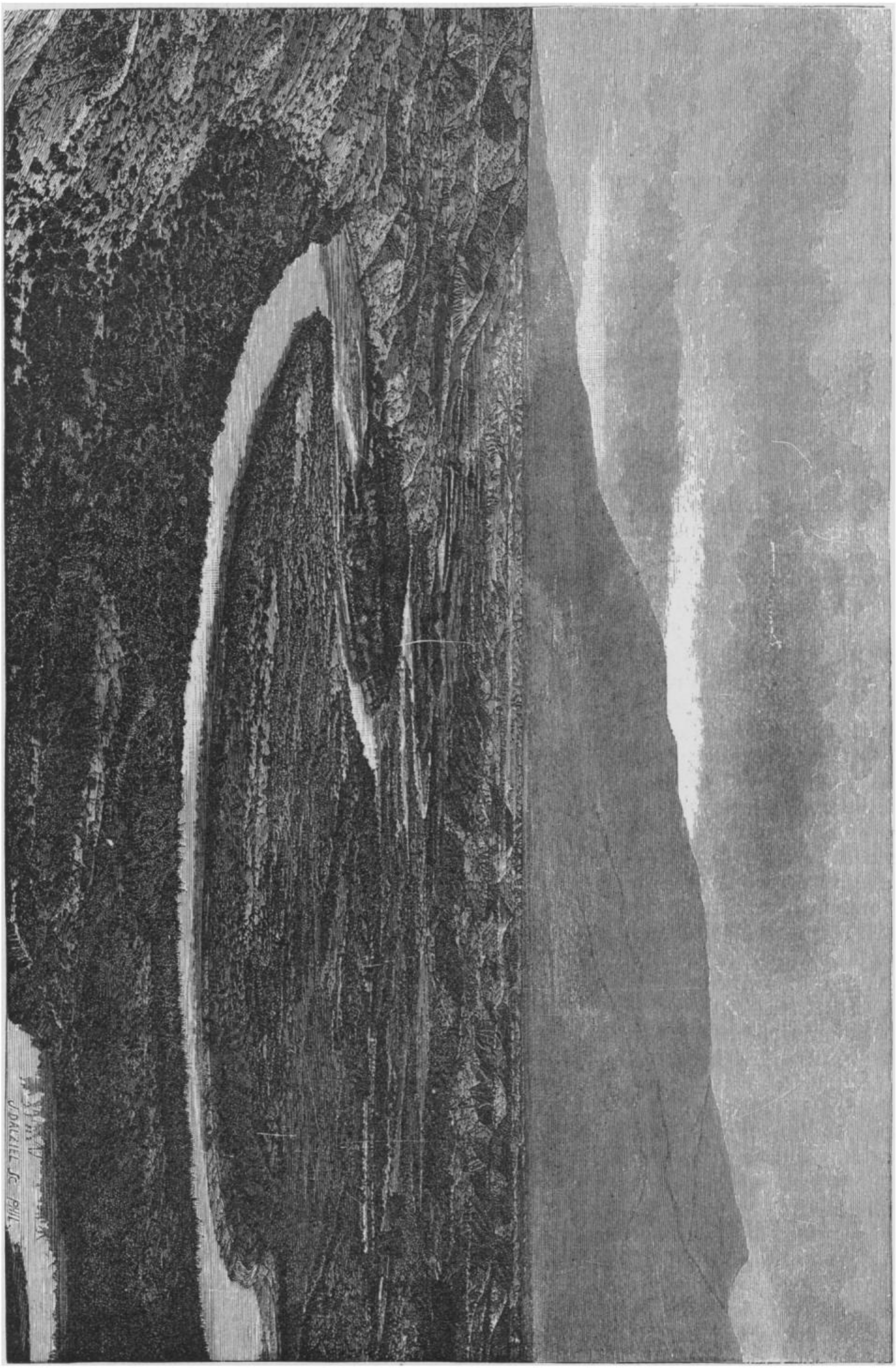
Although the author does not, *we* would correlate this last elevation and its outbursts with the elevation and lava-flows which took place in California at the beginning of the quaternary, and the inner cañon of the Colorado with the deep cañons of the present river-systems of that state. In middle California the pliocene rivers were displaced by the lava-flows, and therefore had to cut new beds. These were cut much deeper than the old, because the country was greatly elevated at that time. But in southern California the country was elevated, but the rivers were not displaced: therefore, like the Colorado, they cut in the same place, but deeper; and remnants of the old beds are now found on the flanks of the present cañons.

Capt. Dutton has sometimes been criticised for a style unbecoming a scientific treatise. We do not agree with these critics. Nothing short of vivid word-painting can give any adequate idea of the peculiar scenery; and certainly in this Capt. Dutton excels. We would especially draw attention to his really magnificent description of the towers of Vermilion Cliffs (p. 86), of the temples and towers of Virgen River (p. 88), and his ride on Kaibab plateau to Grand Cañon (p. 136).

It is needless to say that the memoir is illustrated in a manner worthy of the subject.

It is already well known, through the previous labors of Gilbert and King, that in quaternary times the basin region was largely occupied by two great lakes, separated by the East Humboldt Range. The one occupying Utah basin, of which Great Salt Lake, Utah, Bear, and Sevier Lakes are the residues, was named by Gilbert, Lake Bonneville; while that occupying Nevada basin, and of which Pyramid, Winnemucca, Carson, Humboldt, and Walker Lakes are the residues, was named by Mr. King, Lake Lahontan. The complete study of these lakes has been undertaken by Mr. Gilbert and Mr. Russell. The great importance of this investigation lies in the fact that lakes without outlets are the clearest indicators of changing climate. We can only touch lightly the most important results, referring the reader to the memoir for the proofs.

According to King, in early pliocene a great lake, which he calls Lake Shoshone, covered nearly the whole basin region. This lake seems to have dried away almost completely by the end of the pliocene. At this point Gilbert takes up the history of the region. At the end of the pliocene, Utah basin had a dry climate and a small residuary lake, as at present. During the quaternary, the lake rose until it reached a level nine hundred feet above the present, but did not find an outlet. Then it dried away gradually and probably completely, and its residual salt was buried beneath fine clay, or 'playa deposits' of Mr. Russell. This was followed by a second rising, which reached still higher, and the lake found an outlet into the Snake River. The lake was therefore fresh. The outlet stream cut its way down three hundred feet or more, until, finding a hard limestone, the



LAHONTAN LAKE-BEDS IN HUMBOLDT VALLEY.

lake stood at the six hundred foot level a long time, making a very distinct terrace (Provo terrace). Then by change of climate it lost its outlet, and dried away to its present condition. Mr. Gilbert correlates these changes with the first glacial, the inter-glacial, the second glacial, and the post-glacial periods. Other very important facts brought out by Mr. Gilbert are those connected with recent orographic movements. The floor of Utah basin has recently moved, and is probably still moving. The movement is unequal. The floor is *warping*. The great fault on the west side of the Wahsatch has recently slipped, and will probably again slip. The Wahsatch Range has grown very recently, and is probably still growing. Such slips produce earthquakes. The great Inyo earthquake of 1872 was produced by a slipping of the great fault on the east side of the Sierra, as was first pointed out by LeConte.[1]

Mr. Russell's studies of Lake Lahontan entirely confirm the conclusions of Mr. Gilbert as to climatic changes. This lake also increased from mere residues to a level of five hundred feet above Pyramid Lake. Its shells show that it was at this time fresh; then it dried away completely, burying its salts, if any, beneath playa deposits. Then it rose again to the five hundred and thirty foot level (it was then also fresh); it again dried away to the present residues. Its terraces are traceable all around: it never found an outlet.

Mr. Russell continues the observations, commenced by King, on the remarkable deposits of this ancient lake. He divides these deposits into three kinds, which were made at different stages of the lake. In its first great rise, it deposited a hard, smooth, incrusting lime carbonate (lithoid deposit). At the one hundred foot level and downwards, it deposited what Mr. King calls thinolite, and which he regards as a pseudomorph after gaylussite. In the last and greatest rise, it deposited the dendritic tufa. Mr. Russell calls attention to the fact, that, if thinolite be a pseudomorph after gaylussite, it is difficult to understand what became of the enormous quantity of soda; for the lake never found an outlet. This problem is yet unsolved.

It is seen, then, that Lake Lahontan, like Lake Bonneville, shows two wet periods separated by a dry period, and probably two glacial periods separated by an interglacial period. Evidences of recent orographic movements are noted here also. Nearly all the basin ranges are formed by the tilting of long north and south crust-blocks, each block being dropped on one side, and lifted on the other. The faults thus produced have been slipped very recently, and are probably still slipping. The mountains are still growing.

[1] *Amer. journ. sc.*, vol. xvi. p. 101, 1878.

The three memoirs — of Emmons on the geology of Leadville, of Becker on the Comstock lode, and of Irving on the copper-bearing rocks of Lake Superior — all throw light on the genesis of ore-deposits.

In Mr. Emmons's admirable memoir we have a clear scientific account (the first ever given) of the wonderful argentiferous lead-deposits of Leadville. In this region the mountain system separating the plains from the plateau region consists of three ranges; viz., the Colorado, the Park, and the Sawatch. The first two are separated by the Parks; the last two, by the valley of the Arkansas River. The Park Range, in the vicinity of Leadville, is called the Mosquito Range. On the western slope of the Mosquito Range, or eastern side of Arkansas valley, is situated Leadville. The Mosquito Range consists of crumpled and faulted strata, from the Cambrian to carboniferous inclusive. The ore-deposits are in the carboniferous. Between the carboniferous strata are thick intercalary beds of porphyry, which have been forced between the separated strata without appearing on the surface. This irruption took place during the cretaceous. The whole series, both sedimentary and intercalary-igneous, was then folded and faulted. The mode of occurrence of the ore shows conclusively that it was deposited from solution in percolating water. The ore occurs in a gangue of oxides of iron and manganese, mixed with clay, in cavities and channels in the limestone. The limestone was dissolved and the ore substituted by the same water, the clay being the residuum of the dissolved limestone. The ore was originally disseminated in the porphyry, and thence leached out, and carried downward into the limestone. The original form was sulphides; but in many cases this has been subsequently changed into carbonates, chlorides, etc. It is seen, then, that these are not true fissure-veins, but deposits in irregular water-channels somewhat like the lead ores of Illinois, and like these latter, also, they occur in carboniferous limestone.

These important conclusions of Mr. Emmons in regard to the genesis of ore-deposits are substantially confirmed by Mr. Becker's study of the Comstock lode. This grandest of all lodes is, however, a true fissure-vein. We note only the most important conclusions of this careful memoir.

The vein is at contact of a diabase country on the one side, with a diorite on the other. Mr. Becker finds evidences of repeated slipping. Below, it probably cuts into the diorite. The ore was derived from the eastern diabase country, in the augite of which, analysis still finds the metals in small quantities. The disseminated metals were leached out and carried westward into the fissure, and there accumulated. The solvent water was hot, and contained alkaline carbonates and alkaline sulphides; in other words, was solfataric. The rocks were left in a widely decomposed condition. These conclusions are confirmed by the observations of others, as well as of Mr. Becker himself, on the phenomena of deposit of silica and metallic sulphides from solfataric waters, now going on at Sulphur Bank and Steamboat Springs. It is not unlikely that the process is still going on also in Comstock lode.

On several points Mr. Becker differs from previous observers. Richthofen, in his celebrated memoir on A natural system of igneous rocks, gives a prominent place as a rock species to propylite. Mr. Becker thinks, and probably rightly, that propylite is only an altered andesite, and therefore that the species is untenable. Rosenbusch, however, had already shown that propylite must be regarded as a modification of andesite, and Mr. Becker ought to have stated this fact.

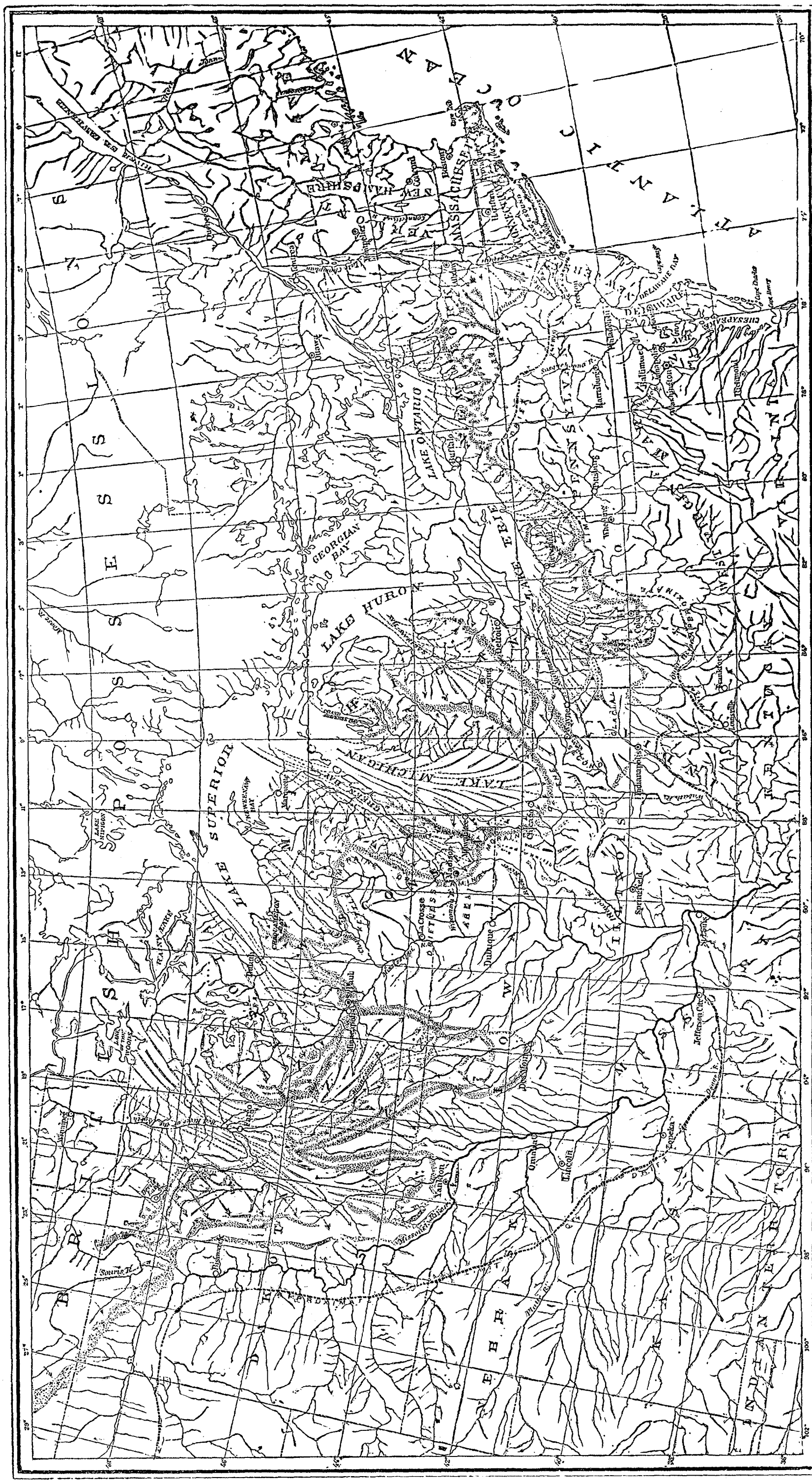
Again Mr. Becker differs (and we think again rightly) from Church as to the source of the heat of Comstock lode. Church ascribed it to kaolinization. Mr. Becker shows the insufficiency of this cause, and suggests as a more probable cause solfataric action, the feeble remnant of previous volcanism.

The memoir of Mr. Irving on the copper-bearing rocks of Lake Superior deals with some of the most vexed questions in geology. When such men as Hunt, Whitney, Selwyn, Wadsworth, and Irving differ as to the age and stratigraphic relations of the copper-bearing series, those who have not personally examined the ground have no right to an opinion. Mr. Irving's view is, that this series partly fills the great gap between the Huronian and the Cambrian. It consists of sandstones and conglomerates, with interbedded sheets of igneous rocks, mostly basic; the whole being of enormous thickness.

As to the mode of occurrence and origin of the ore, there is a resemblance to, yet striking difference from, that of Leadville. As in Leadville, so here, we have alternating sheets of strata and lava; also, in both, the ore seems to have been leached from the igneous, and gathered in fissures, cavities, water-channels of any kind in the intervening strata, by means of down-percolating water; also, in both, the deposit seems to have been made by substitution; although the explanation of the substitution is more difficult in this case. But, on the other hand, the age of the strata is pre-Cambrian instead of carboniferous; the strata are conglomerates and sandstones instead of limestones; and the intercalary beds are contemporaneous instead of subsequent, i.e., poured out on the surface, and covered with sediments, instead of forced between the strata. As to the obscure question of the reactions by which ore was deposited, the author seems to adopt Pumpelly's view, that the copper was carried in solution as sulphate, and was reduced by the iron of the basic rocks, which oxidized itself at the expense of the copper sulphate.

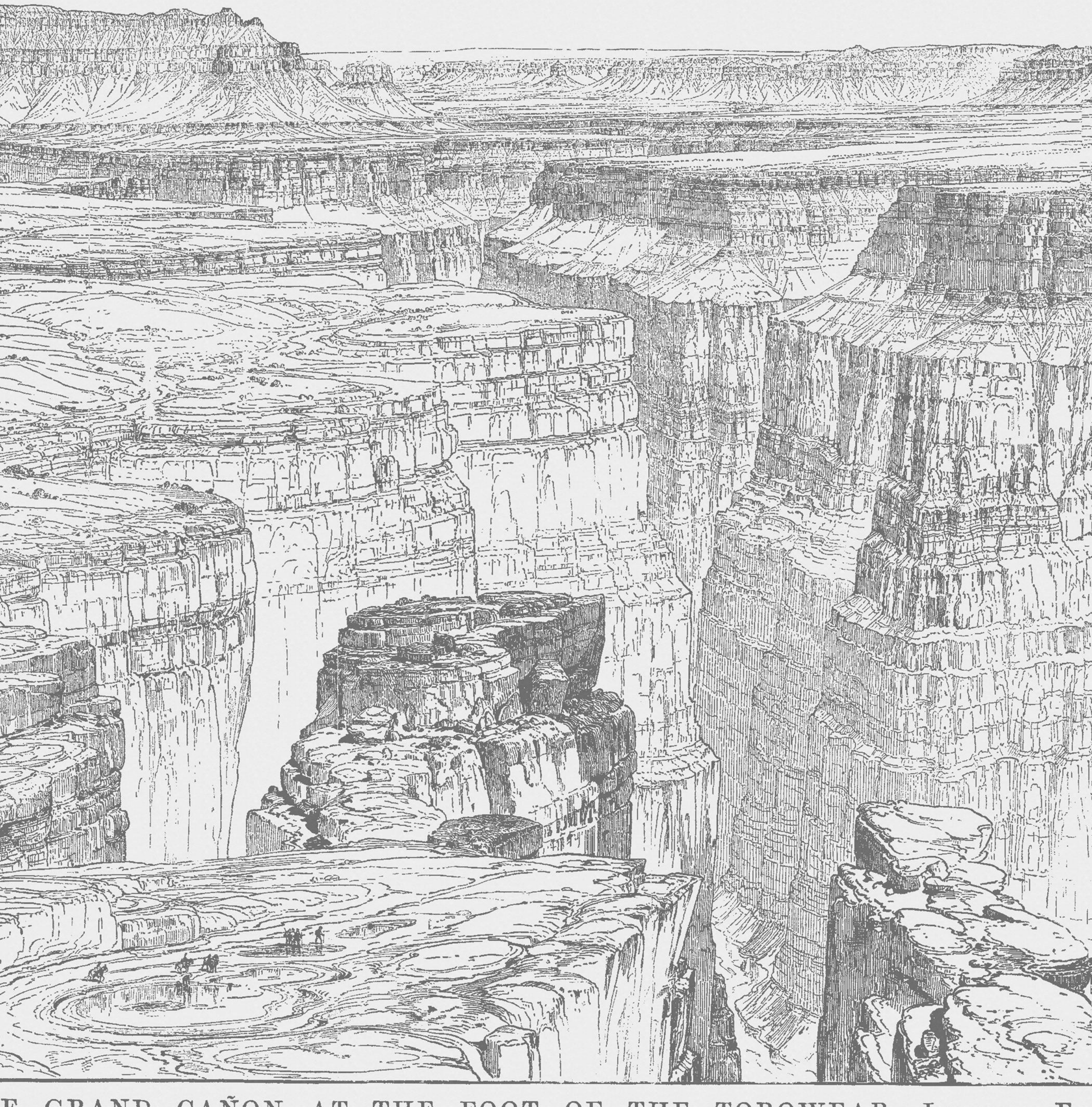
The memoir of Hague on the Eureka district does not touch the mines of this district: that is left for a future memoir. It is confined wholly to descriptive geology. As such, although not entertaining popular reading, it is a model of painstaking, conscientious work. It is on such work, and such only, that a true geological science must be built. Only one point we have time to notice. Mr. Hague declares that there is no trachyte at all among the western eruptive, what has gone under that name being andesite. This decision is founded on the fact that plagioclase is the dominant felspar in all of them. The fact admitted, the decision seems well founded. But surely some consensus of view as to the basis of classification of eruptive is devoutly to be wished for. Shall it be the look and habit, or mode of occurrence, or mineral constitution, or age, or all these together? When shall order come out of this chaos?

It is a pity that Mr. Chamberlin's paper on the second glacial moraine comes last among the geological articles; for we are pressed for room, and the subject is to us a specially inviting one. The author commences his work by trying to remove the confusion which exists on the subject of drift-deposits. He makes three kinds of till: viz., 1, subglacial or true till; 2, englacial or superglacial till (a looser top material); 3, subaqueous till, often confounded with the first, but deposited by floating ice. He also distinguishes between osars and kames. After many other distinctions which deserve studious attention, he describes the peculiar structure and appearance of terminal moraines, and then applies these principles to the identification and tracing of the second glacial, or

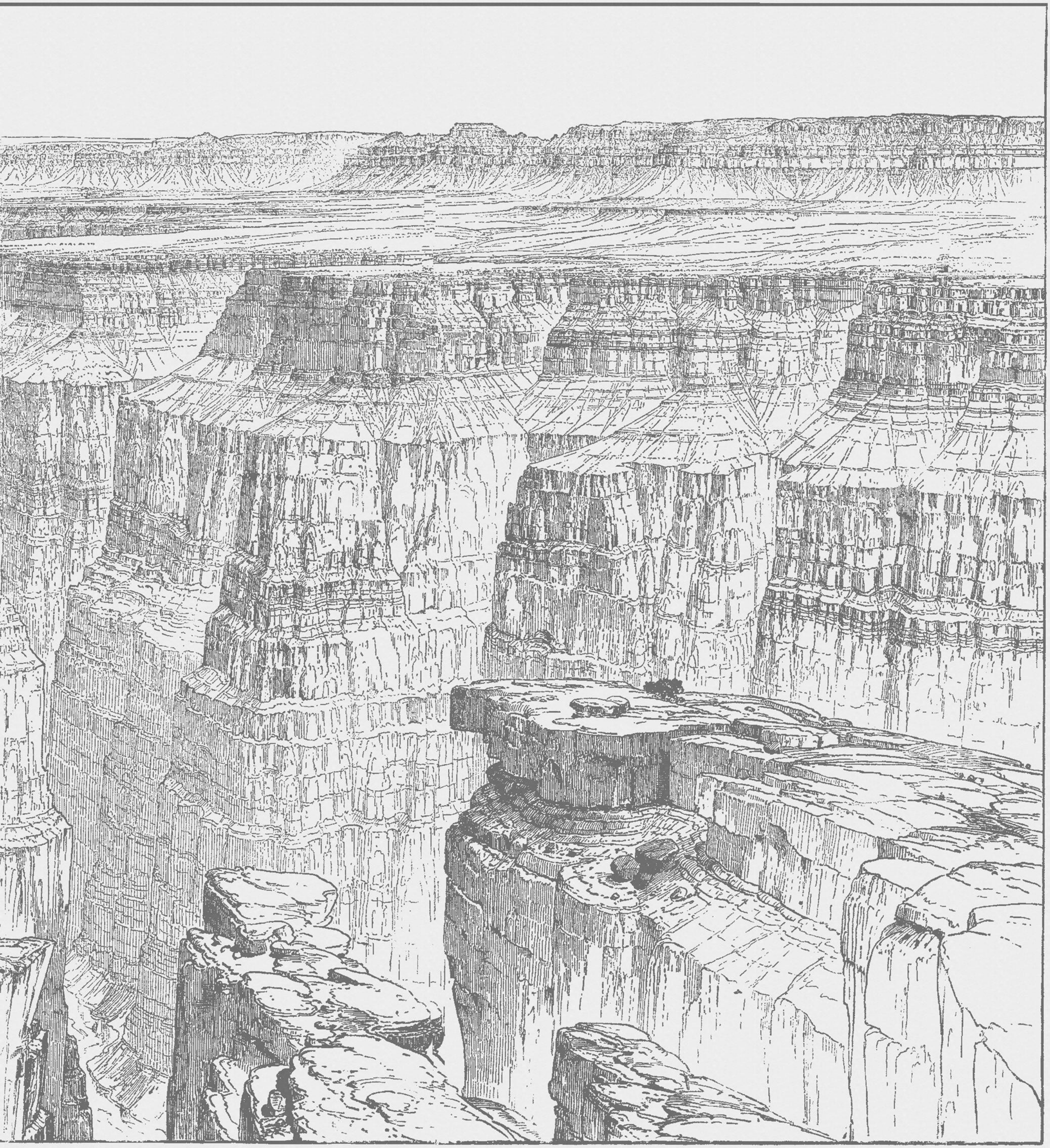


GENERAL MAP OF THE TERMINAL MORAINE OF THE SECOND GLACIAL EPOCH.

THE GRAND CAÑON AT THE



E GRAND CAÑON AT THE FOOT OF THE TOROWEAP, Looking Ea



HE TOROWEAP, LOOKING EAST.

so-called 'kettle' moraine. As is well known, chiefly through the work of the author, together with Upham and others, this moraine consists of a series of loops about the Great Lakes, and continuing thence eastward and westward. Commencing with the Green-Bay loop as most typical, the author describes every loop separately and minutely, taking them in succession going eastward, and then returning and going westward. All we can do here is to trace briefly the course of this moraine as shown in the map, plate xxviii.

Commencing eastward, this moraine passes through Cape Cod and through Long Island, to New York. This part is often described as the first glacial or *limit moraine*. If so, the two are here coincident. But possibly the true limit is farther out to sea; or, more probably, the ice-sheet at its farthest limit ran out here into the sea, and formed no moraine at all, its *débris* being carried away by icebergs. From New York the two moraines separate, the limit moraine passing through New Jersey and Pennsylvania, where it has been traced by Cook and Lewis; while the second glacial moraine turns northward into middle New York, passes in a curve around the Finger Lakes, and then southward to join the limit moraine in eastern Ohio. After running together a little way, they again part company, the limit moraine passing along an irregular line a little north of the Ohio River, then crossing the Mississippi and following the south and west side of the Missouri River into Montana and British America; while the second moraine turns northward, sweeps about the Great Lakes in a succession of loops, and then, making two more grand loops, — one in Iowa and one in Dakota, — it finally passes along the Coteau of the Missouri, and onward into British America.

The importance of the work of Mr. Chamberlin and Mr. Upham, in connection with that of Messrs. Cook, Lewis, and Wright, on the first glacial or limit moraine, in their bearing on the question of the existence of a veritable ice-sheet, cannot be overestimated.

In the paper on barometric measurements by Mr. Gilbert, a new method of measuring heights is brought forward. The essentials of this method are as follows: —

For the purposes of observation there are two base stations, one high and one low, the difference in altitude between them being as great as possible, compatible with close verticality. At these two stations, only the barometer and its attached thermometer are observed, no other instrument being considered necessary. The actual difference in altitude between these base stations is determined by spirit-level; and this constitutes the altitude, — a vertical base-line, by which all other altitudes are gauged.

The field-notes consist of barometric readings applying to the upper base station, the lower base station, and the new station, respectively.

The method of computation consists in first correcting the instrumental readings for index-error and temperature. These readings are then collected in groups of three, each observation at a new station being associated with the coincident observations at the base stations. The altitude of the upper base station is then computed as usual, without applying the corrections for moisture, temperature, or gravity; and the height of the new station above the lower base station is calculated in the same way, thus assuming that the air is dry, and has a uniform temperature of 32° F.; and, these two results being considered approximate, the following proportion is made: —

Approximate height of base-line : True height of base-line : :
Approximate height of new station : True height of new station.

There is little of importance in this publication that has not appeared previously in some form or other.

Of course, the method would, in the first place, be limited in its application to a very small horizontal area; for only in such an area could the conditions of density be similar enough to allow of its use: and the first thought that would strike one would be the comparatively rare occurrence of the conditions of verticality proposed, though the method certainly has the mark and merit of ingenuity.

Most of such devices are designed to do away with the influence of the 'hour of the day,' as it is called, or the varying effect of the different conditions of temperature and moisture. Any real control over these elements in the problem must come from the careful noting of all the circumstances under which the data are collected; and the question can only be decided, if it ever is, by observations continued for a long time.

The only great effort to secure the data for this 'horary' correction was made by Plantamour, in his discussion of the forty-year series of observations carried on between Geneva and the St. Bernard hospice:[1] but this series only covers one of the many conditions under which such measurements may be made, for decided differences would be introduced by unequal insolation along mountain chains, near

[1] Mém. Soc. phys. Genève.

plateaus (whether high or low), on the coast, or in different seasons; and it would seem from these records that the only means of obliterating the effect of these temporary disturbances is in having a large number of observations made, and taking their average.

This would also seem to throw some doubt upon the value of Williamson's method of obtaining this correction from the curve of the day: for days differ so much that a large arbitrary or constructive element would be introduced, thereby damaging the results as far as scientific accuracy is concerned; for we can easily see that the difference between a clear, bright day, and a day in which the sky might be wholly or partly covered, would be great, and therefore much would be left to the judgment of the observer with regard to applying the whole or only a part of any correction which might be obtained for use in such cases:[1] for, at best, we only get a sort of skeleton average from the mathematical formulae; and it is quite certain that the formula of Laplace gives too high results for general use, since it is only adapted for the summer months.

The second objection to this method, therefore, would seem to be found in the comparatively arbitrary use of the data obtained.

If we could only obtain a partial solution of this problem by securing a portion of the proper correction, it would be a great gain.

The temperature correction would not, perhaps, be so difficult to obtain; but, when we once introduce the element of moisture, we perceive that the uncertainty of controlling the conditions increases, except by having full averages of all the elements involved, as their variability is so great.

One has only to look into the work of Plantamour to become convinced of this; and the results obtained from these records, as worked out by Dr. Guyot, show it conclusively.

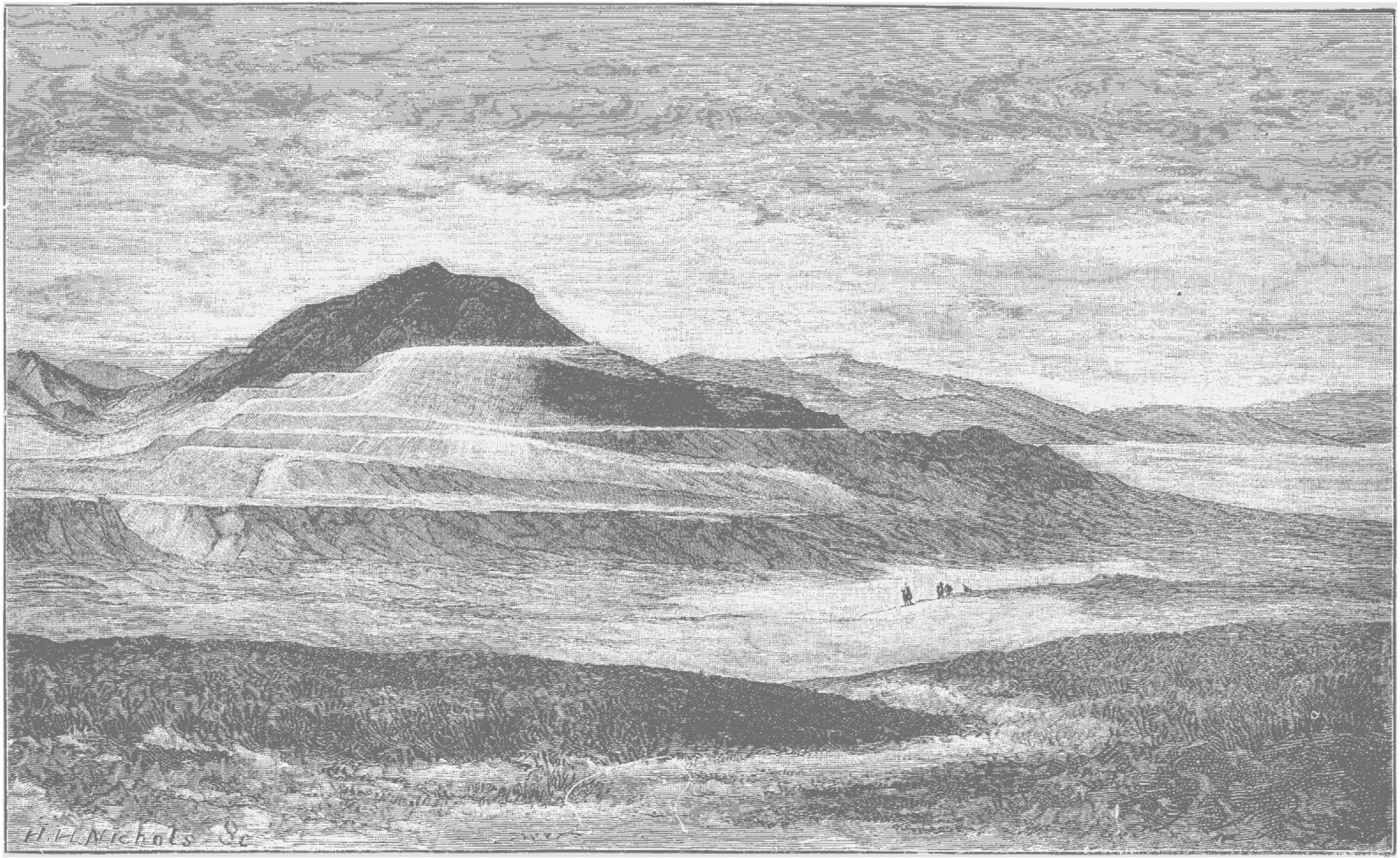
It has therefore been Dr. Guyot's principle to simplify the methods, both of observation and of computation, as much as possible, so as to facilitate the making of a large number of observations, and from their averages obtaining better results. By this means the original records are touched as little as possible; and the results are sufficiently accurate for the purposes of the geographer.

The trouble is, that these difficulties arise from the nature of the problem; and it is very doubtful whether they will ever be completely mastered.

There is another objection to the proposed method, which would seem vital; and that is, that it materially increases the cost of such a survey, not only by the employment of an additional observer, but also by making the measurement of a number of vertical base-lines by level a necessity in an extended survey; and any thing which does this, thereby bringing the expenses nearer to the amount necessary for a regular levelling-survey without proportionally increasing the accuracy of the results obtained (for the liability to errors of observation and computation is greater), is at least of questionable advantage.

[1] Bulletin No. 2, E. M. museum of geology and archaeology.

In his 'Non-marine fossil Mollusca,' Dr. C. A. White presents a valuable review of the North-American brackish, fresh-water, and land Mollusca, beginning with their first representatives in the Devonian, and tracing the history of many cases of persistence to modern forms. Every paleontologist has to contend with large gaps in material; and these are more extensive among the inland than among the marine Mollusca. Another difficulty lies in distinguishing between the brackish and fresh and salt water forms. These are often commingled, especially in the Laramie rocks, which bear evidences of frequent littoral changes in the estuaries and inland seas. Following a geological introduction, the author presents an elaborate historical catalogue of the genera of the Conchifera and Gasteropoda. There is a happy omission of any attempt at revision of species (an endless task), and little technical description; while more attention than usual is given to the interesting question of changes of habitat during successive periods, and relationships with other fossil and modern forms. A curious fact, which has so many parallels among the other Mollusca, is the early appearance and development of the pulmonate gasteropods, which are found as low as any of the Conchifera. With the necessary presumption of the derivation of the non-marine from the marine types, the author infers that this has taken place not only in paleozoic, but in more recent geological times. The marine types, having suffered the fewest changes of environment, have been the most persistent; then rank the land and brackish-water types; but, in view of the continual changes in the fresh-water areas, the persistence, even to the present day, of several fresh-water forms, is most remarkable. According to the author, the latter forms abounded in the great tertiary lakes: they survived the contraction of the lakes into the great river-systems, and they owe their wide dispersal to the confluence of these river-systems, as in the case of the Ohio and Mississippi, which originally poured into the Gulf. It appears that



RESERVOIR BUTTE, SHOWING TERRACES OF THE BONNEVILLE SHORE-LINES.